Patent Application Number: 09/360,582
Attorney Docket Number: MIT.8312

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

On behalf of

Brandon W. **BLACKBURN**

APPELLANT

APPLICATION: 09/360,582 **EXAMINER: J. Mondt**

FILED: July 26, 1999 **GROUP: 3641**

CONFIRMATION: 4382

Title: LIQUID GALLIUM COOLED HIGH POWER NEUTRON SOURCE TARGET

APPELLANT'S BRIEF ON APPEAL

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FOR: LIQUID GALLIUM COOLED HIGH POWER NEUTRON SOURCE TARGET

Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313–1450

Sir:

APPEAL BRIEF FOR APPELLANT

This Appeal Brief is being submitted in accordance with the Notice of Appeal filed on February 29, 2008 in connection with the above-identified application.

I. REAL PARTY OF INTEREST

The party of real interest to this appeal is the Assignee, Massachusetts Institute of Technology.

II. RELATED APPEALS AND INTERFERENCES

The Appellant knows of no other pending appeals or interferences that are related to this instant appeal.

III. STATUS OF CLAIMS

Claims 1-8 were originally presented in this application. Claims 2, 3, and 6 have been cancelled without prejudice or disclaimer to the subject matter contained therein. Claims 1, 4, 5, 7, and 8 are pending in this application. Claims 1, 4, 5, 7, and 8 are appealed.

IV. STATUS OF AMENDMENTS

The Appellant submitted a single Response under 37 C.F.R. 1.116 with no amendments. The Appellant has not filed any other Responses and/or Amendments subsequent to the Final Office Action, dated November 1, 2007.

V. SUMMARY OF CLAIMED SUBJECT MATTER

In accordance with 37 C.F.R. 41.37(2)(c)(v), the following are concise explanations of the subject matter defined in the independent claims (1, 5, and 8) involved in this Appeal.

Independent Claim 1

Independent claim 1 recites a method of cooling a low Z target material of a neutron source assembly. The method provides, by using a nozzle submerged in liquid gallium (see, for example, reference 34 of Figure 2 and page 5, line 13, through page 6, line 8, of the originally filed specification), a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the neutron source assembly to cool the low Z target material (see, for example, Figure 2

and page 5, line 13, through page 6, line 8, of the originally filed specification); provides a reservoir of liquid gallium (see, for example, Figure 6 and page 11, line 20 through page 12, line 2, of the originally filed specification); and pumps the liquid gallium, serially (see, for example, Figure 1 and page 5, lines 13-20, of the originally filed specification), from the reservoir (see, for example, reference 14 of Figure 6 and page 5, lines 13-20, of the originally filed specification), through the nozzle (see, for example, reference 34 of Figure 2 and page 5, line 13, through page 6, line 8, of the originally filed specification), such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger (see, for example, reference 24 of Figure 6 and page 5, lines 13-20, of the originally filed specification) to remove heat from the liquid gallium, and from the heat exchanger to the reservoir (see, for example, Figure 1 and page 5, line 13, through page 6, line 8, of the originally filed specification).

Independent Claim 5

Independent claim 5 recites a neutron source assembly having a liquid cooled target. The neutron source assembly comprises an accelerator based neutron source including a low Z target material that is bombarded by accelerated particles to produce a neutron flux (see, for example, references 30, 32, 33, and 34 of Figure 2 and page 5, line 13, through page 6, line 8, of the originally filed specification), and a cooling system to circulate liquid gallium through the accelerator based neutron source to cool the low Z target material (see, for example, Figure 1 and page 5, lines 13-20, of the originally filed specification).

The cooling system includes a nozzle, the nozzle being submerged in liquid gallium (see, for example, reference 34 of Figure 2 and page 5, line 13, through page 6, line 8, of the originally filed specification), providing a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the accelerator based neutron source.

The cooling system further includes a reservoir of liquid gallium (see, for example, reference 14 of Figure 6 and page 5, lines 13-20, of the originally filed specification), a heat exchanger (see, for example, reference 24 of Figure 6 and page 5,

lines 13-20, of the originally filed specification), and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir (see, for example, connections of Figure 1 generally and reference 16 of Figure 1 and page 5, lines 13-20, of the originally filed specification).

Independent Claim 8

Independent claim 8 recites a liquid cooling system for a neutron source assembly. The liquid cooling system for a neutron source assembly comprises a reservoir of liquid gallium (see, for example, reference 14 of Figure 6 and page 5, lines 13-20, of the originally filed specification); a heat exchanger (see, for example, reference 24 of Figure 6 and page 5, lines 13-20, of the originally filed specification); a nozzle, the nozzle being submerged in liquid gallium (see, for example, reference 34 of Figure 2 and page 5, line 13, through page 6, line 8, of the originally filed specification), providing a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of a low Z target material within the neutron source assembly; and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir (see, for example, connections of Figure 1 generally and reference 16 of Figure 1 and page 5, lines 13-20, of the originally filed specification).

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Rejection under 35 U.S.C. §112, First Paragraph

The issue is whether the specification provides a proper written description to support claims 1, 4, 5, 7, and 8 in accordance with 35 U.S.C. §112, first paragraph.

B. Rejection of claims 1, 4, 5, and 7 under 35 U.S.C. §103

The issue is whether claims 1, 4, 5, and 7 are patentable over Eggers (US Patent 5,392,319) in view of Lidsky et al. (US Patent 5,784,423), Pias et al. (IEEE Article), and Alger et al. (US Patent 4,141,224) in accordance with 35 U.S.C. §103.

C. Rejection of claim 8 under 35 U.S.C. §103

The issue is whether claim 8 are patentable over Eggers (US Patent 5,392,319) in view of Eggers (US Patent 5,392,319) in view of Lidsky et al. (US Patent 5,784,423), Pias et al. (IEEE Article), and Alger et al. (US Patent 4,141,224) in accordance with 35 U.S.C. §103.

VII. ARGUMENTS

A. Rejection under 35 U.S.C. §112, First Paragraph

Claims 1, 4, 5, 7, and 8 have been rejected under 35 U.S.C. §112, first paragraph, for failing to provide a written description of the claimed invention. This rejection, in view of the above amendments, is moot.

In formulating the rejection under 35 U.S.C. §112, first paragraph, the Examiner alleges that the originally filed specification fails to provide a written description of a nozzle submerged in liquid gallium.

Figure 2 is a cross-sectional illustration of the neutron generating portion of the accelerator based neutron source 12 of Figure 1 and associated cooling system. The portion of the accelerator based neutron source 12, as set forth in the originally filed specification (at page 6, lines 1-3), includes a stainless steel housing 31 within which is

a beryllium target 32. This target is bombarded with either protons or deuterons on a surface 33 of the beryllium target 32. As a result of proton or deuteron interactions in the beryllium target 32, a neutron flux is generated, as set forth in the originally filed specification (at page 6, lines 3-4). The neutron flux passes through the gallium-filled reservoir and stainless steel housing and is emitted from the accelerator based neutron source 12. Since the heat flux in the beryllium is extremely high, the present invention utilizes liquid gallium to cool the beryllium target 32, as set forth in the originally filed specification (at page 6, line 4).

The accelerator based neutron source 12, as illustrated in original Figure 2 and as set forth in the originally filed specification (at page 6, lines 5-6), includes a stainless steel nozzle 34 that receives the liquid gallium and injects a concentrated jet of liquid gallium 37 onto the back surface 39 of the beryllium target 32. Since the outlet 30, as illustrated in original Figure 2, from the stainless steel housing 31 is located above the top surface of the beryllium target 32, the reservoir 40 will fill with liquid gallium. More specifically, the originally filed specification, at page 6, lines 7-8, explicitly states that liquid gallium fills the chamber 40 and exits therefrom.

In response to this position, the Examiner states, "the absence of a teaching of partial (incomplete) fill does not imply a complete fill." This rebuttal by the Examiner does not appear to have any relevance to the Applicant's position. The Applicant asserts that the originally filed specification explicitly teaches that the liquid gallium fills the chamber 40 and exits therefrom. Therefore, the chamber must be filled with liquid gallium before exiting because if the liquid gallium is allowed to exit prior to filling the chamber, the chamber will never fill, and thus, such a situation would be antithetical to the express teaching of the originally filed specification.

The originally filed specification expressly sets forth that the chamber is filled. Absence any statements to the contrary, the plain and ordinary meaning of this teaching must control; i.e., the chamber ifs filled with liquid gallium, not partially filled.

Thus, the originally filed specification teaches that the jet of liquid gallium 37 is submerged in the reservoir 40 because the reservoir 40 is filled with liquid gallium.

The liquid gallium will exit out of the housing through the outlet 30 from where the liquid gallium will be piped to the heat exchanger 24 to remove the latent heat.

In addressing the Applicant's arguments, the Examiner alleges that Figure 2 fails to illustrate that nozzle 34 is even in chamber 40. This assertion by the Examiner is unsupportable in view of the original specification. The original specification (at page 5, line 6) indicates, "Figure 2 is **a cross-sectional illustration** of the neutron generating portion of the accelerator based neutron source." [Emphasis added.]

Thus, Figure 2 illustrates all the objects with respect to a certain plane. Since nozzle 34 is illustrated with chamber 40 and the illustration is a cross-sectional view, nozzle 34 must be in chamber 40, otherwise the view cannot be a cross-sectional view.

The Examiner asserts that a cross-sectional view can only show overlap, not three dimensional containment. This assertion appears to be non-relevant to the Applicant's position.

As illustrated in the cross-sectional view of Figure 2, the nozzle 34 is within the chamber 40. If the nozzle 34 was not within the chamber 40, Figure 2 would not show nozzle 34 because Figure 2 is a cross-sectional view.

More specifically, if the nozzle 34 was above the chamber 40, it would not have been shown because nozzle 34 would not have been positioned along the cross-sectional plane. Moreover, if the nozzle 34 was below the chamber 40, it would not have been shown because nozzle 34 would not have been positioned along the cross-sectional plane. Thus, since Figure 2 is a cross-sectional view, Figure 2 clearly illustrates that the nozzle 34 is within the chamber 40.

The Examiner further counters that even if the nozzle 34 is in chamber 40, the original specification fails to teach that the chamber 40 is filled enough to submerge the nozzle 34. The original specification explicitly states that the liquid gallium **fills** the chamber 40. The original specification does **NOT** teach a partial fill. Thus, the ordinary meaning of the original specification clearly teaches the skilled artisan that the chamber 40 is filled enough to submerge the nozzle 34.

As noted previously, the original specification, at page 6, lines 9-20, indicates that the testing of the invention with a water coolant produced a submerged jet impingement. More specifically, the original specification, at page 6, lines 18-20, the specification expressly states that only parameter being changed is the utilization of liquid gallium over water.

This teaching corresponding to a device wherein the water jet is submerged that subsequently liquid gallium replaces water is consistent with the understanding that the chamber is filled with liquid gallium and the liquid gallium jet is submerged. Thus, the same configuration using liquid gallium would produce a submerged jet impingement.

To bolster the Examiner's arguments, the Examiner states that Pais et al. teaches the creation of a submerged jet without a submerged nozzle.

As taught by Pais et al. (on page 182, first sentence of the third paragraph), the various submerged jet impingement configurations were realized by utilizing a submerged nozzle. More specifically, Pais et al. teaches, at the end of the article, on page 182, first sentence of the third paragraph, that "in all of the above cases the surface [target] and nozzle were fully submerged." Thus, in every example of a submerged jet scenario provided by Pais et al., Pais et al. explicitly teaches the existence of a submerged nozzle to realize the submerged jet.

It is noted that Pais et al. teaches a free jet impingement configuration wherein the nozzle is not submerged. However, this situation does not involve a submerged jet, but a free jet.

Therefore, the Examiner's argument that Pais et al. teaches the existence of a submerged jet without realizing a submerged nozzle is contrary to the explicit teachings of Pais et al. More specifically, Pais et al. teaches, at the end of the article, on page 182, first sentence of the third paragraph, that "in all of the above cases the surface [target] and nozzle were fully submerged." The submerged nozzle, as taught by Pais et al., created a submerged jet.

The Examiner contends that since pages 7 and 8 of the original specification does not mention a submerged jet or submerged nozzle when describing a liquid gallium test, the specification clearly fails to a submerged nozzle. It is noted that pages 7 and 8 also do not mention the chamber, the heat exchanger, etc.

In view of this omission, it appears that the Examiner would contend that the original specification also does not support any elements of the claims because the description of the liquid gallium test fails to mention each of these claimed elements.

In rebuttal to this position, the Examiner contends that the Applicant is correct that other locations in the specification may provide support for the claimed invention, but pages 7 and 8 "would have been a natural one given the subject matter."

35 U.S.C. §112, first paragraph, does not place specific requirements upon the Applicant as to how the Applicant should set forth the written description, just that the Applicant provide a written description. To hold a specification deficient with respect to 35 U.S.C. §112, first paragraph, because the Examiner desire the description at a certain location because that location "would have been a natural one given the subject matter" is clearly outside the scope of the statutory basis for rejecting claims under 35 U.S.C. §112, first paragraph.

Therefore, it is arbitrary and capricious for the Examiner to make a rejection 35 U.S.C. §112, first paragraph, because the Examiner believes a certain portion of the specification "would have been a natural" location for the described invention "given the subject matter."

Lastly, the Examiner contends that the disclosure is silent with respect to the outlet being located at the top surface of the target. Notwithstanding, the Examiner asserts that the nozzle 34 of Figure 2 of the above-identified application need not be submerged when producing a submerged jet.

Since the Examiner has recognized that the originally filed specification teaches a submerged jet, the Applicant respectfully requests that the Examiner clearly demonstrate, using Figure 2 as a basis, how the liquid gallium travels from the nozzle, produces a submerged jet which impinges upon the target, and exits out the outlet without submerging the nozzle.

If the Examiner cannot demonstrate how the liquid gallium travels from the nozzle, produces a submerged jet which impinges upon the target, and exits out the outlet without submerging the nozzle, Figure 2 must necessarily illustrate the submersion of the nozzle to produce a submerged jet which impinges upon the target.

To demonstrate the Applicant's position and to demonstrate that the Examiner cannot establish a configuration wherein the liquid gallium travels from the nozzle, produces a submerged jet which impinges upon the target, and exits out the outlet

without submerging the nozzle, Figure 2 has been annotated to show the necessary liquid gallium level to facilitate both exiting from the outlet and creating a submerged jet.

In the first annotation of Figure 2, the neutron generating portion of the accelerator based neutron source is orientated such that the outlet is above the nozzle. In this annotation, it is very clear that the level **A** of the liquid gallium would be such to submerge the nozzle in order to both exit the outlet and create a submerged jet 37.

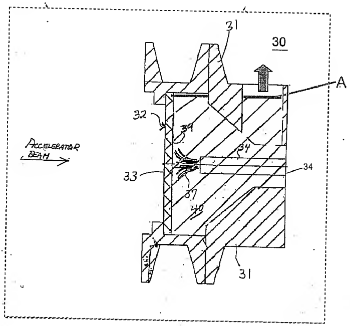

FIG. 2

In the second annotation of Figure 2, the neutron generating portion of the accelerator based neutron source is orientated such that the outlet is below the nozzle. In this annotation, it is very clear that the level **A** of the liquid gallium would be such to submerge the nozzle in order to both exit the outlet and create a submerged jet 37.

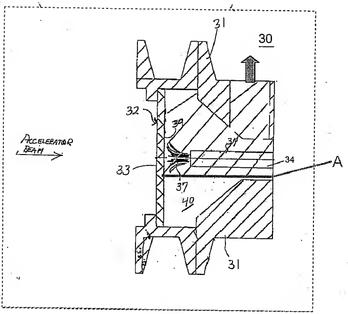

FIG. 2

Accordingly, in view of all the reasons set forth above, the Honorable Board is respectfully requested to reconsider and overturn the present rejection under 35 U.S.C. §112, first paragraph.

B. Rejection of claims 1, 4, 5, and 7 under 35 U.S.C. §103

Claims 1, 4, 5, and 7 have been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US Patent 5,392,319) in view of Lidsky et al. (US Patent 5,784,423), Pias et al. (IEEE Article), and Alger et al. (US Patent 4,141,224). This rejection is respectfully traversed.

Independent Claim 1

As submitted above, independent claim 1 sets forth a method of cooling a low Z target material of a neutron source assembly by providing, by using a nozzle submerged in liquid gallium, a submerged jet of concentrated liquid gallium in a

direction normal to a non-bombarded surface of the low Z target material within the neutron source assembly to cool the low Z target material; providing a reservoir of liquid gallium; and pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that

Pais et al. teaches a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

To meet this deficiency in the combined teachings of Eggers, Lidsky et al., and Pais et al., the Examiner proposes to modify the teachings with the teachings of Alger et al. The Examiner contends that Alger et al. teaches pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Notwithstanding the Examiner's contentions, Alger et al. teaches pumping a liquid coolant, serially, from the reservoir (23), through the nozzle (29), such that the liquid coolant impinges upon a target material (11) in chamber (13) and cools the target

material (11). Alger et al. further teaches that the liquid coolant exits the chamber (13) and flows directly back to the reservoir (23).

Lastly, Alger et al. teaches that the liquid coolant in the reservoir (23) may be pumped serially, from the reservoir (23), back through the nozzle (29), or the liquid coolant in the reservoir (23) may travel through a heat exchanger (28).

In other words, Alger et al. teaches that the liquid coolant leaving the chamber (13) is fed directly to the reservoir (23) and that the liquid coolant **may** pass through the heat exchanger (28).

In contrast, independent claim 1 explicitly recites that pumping the liquid gallium, **serially, from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Thus, Alger et al., unequivocally, fails to disclose or suggest pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**, as set forth by independent claim 1.

In rebuttal to this position, the Examiner contends that Figure 1 of Alger et al. illustrates pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

As illustrated below, Figure 1 of Alger et al. illustrates pumping of the liquid gallium, serially, from the reservoir, through the nozzle, and from the neutron source assembly directly to the reservoir. Once in the reservoir, Alger et al. illustrates that the liquid gallium may travel directly back to the pump or the liquid gallium travel directly to a heat exchanger to remove heat from the liquid gallium. In this second scenario, the liquid gallium then travels from the heat exchanger to the reservoir.

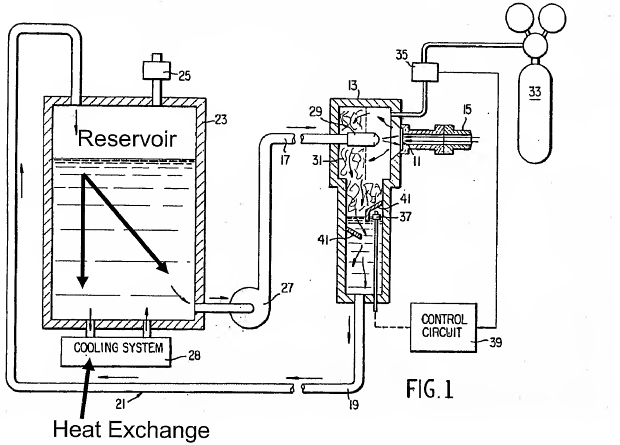

FIG.1

As noted above, independent claim 1 sets forth pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Thus, Alger et al., unequivocally, fails to disclose or suggest pumping the liquid gallium, **serially**, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Lastly, in addressing the Applicant's arguments, the Examiner dismisses the contention that the liquid gallium of Lidsky et al. is incompatible with the systems of Eggers and Pais et al. due to its corrosive nature and asserts that the Applicant has

admitted that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly.

Initially, the Examiner is respectfully requested to substantiate the validity of the Examiner's contention that the Applicant has admitted that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly.

The original specification does not discuss copper as being a material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly. Moreover, the Applicant has not expressly stated in any of the previous Response that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly. Therefore, the Examiner is respectfully requested to withdraw the unverifiable statement regarding Applicant's admissions concerning copper and further to refrain from making such unverifiable statements in future Office Actions.

The Examiner also asserts that Morel et al. (US Patent 6,258,620) discusses a liquid gallium container made of copper. It is respectfully noted that the Examiner has failed to formally include Morel et al. as a reference upon which the rejection under 35 U.S.C. §103 is based.

Although Morel et al. discloses, at column 5, lines 15-27, a shallow container made of copper for providing a liquid gallium sputtering source, Morel et al. fails to disclose liquid gallium can be utilized with a copper or aluminum based neutron source assembly as disclosed by Eggers.

It is respectfully submitted that shallow container made of copper for providing a liquid gallium sputtering source, as taught by Morel et al., is not subjected to the temperatures experienced within a neutron source assembly. As noted above, the inappropriateness of is temperature dependent. More specifically, the dissolution of the copper is temperature dependent.

Thus, since the temperatures within a neutron source assembly are very high, the use of liquid gallium as a coolant in a copper based neutron source assembly would be very problematic because the copper based neutron source assembly would begin to dissolve in the presence of the liquid gallium coolant.

Moreover, the Examiner has failed to demonstrate how Morel et al. teaches that copper is an adequate material for use with liquid gallium in an environment that is subjected to the temperatures realized within a neutron source assembly.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

Independent Claim 5

As submitted above, independent claim 5 sets forth a neutron source assembly having a liquid cooled target. The neutron source assembly includes an accelerator based neutron source including a low Z target material that is bombarded by accelerated particles to produce a neutron flux and a cooling system to circulate liquid gallium through the accelerator based neutron source to cool the low Z target material. The cooling system includes a nozzle, the nozzle being submerged in liquid gallium to provide a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the accelerator based neutron source. The cooling system further includes a reservoir of liquid gallium; a heat exchanger, and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the accelerator based neutron source, from the accelerator based neutron source directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that Pais et al. teaches a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling

a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

To meet this deficiency in the combined teachings of Eggers, Lidsky et al., and Pais et al., the Examiner proposes to modify the teachings with the teachings of Alger et al. The Examiner contends that Alger et al. teaches pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Notwithstanding the Examiner's contentions, Alger et al. teaches pumping a liquid coolant, serially, from the reservoir (23), through the nozzle (29), such that the liquid coolant impinges upon a target material (11) in chamber (13) and cools the target material (11). Alger et al. further teaches that the liquid coolant exits the chamber (13) and flows directly back to the reservoir (23).

Lastly, Alger et al. teaches that the liquid coolant in the reservoir (23) may be pumped serially, from the reservoir (23), back through the nozzle (29), or the liquid coolant in the reservoir (23) may travel through a heat exchanger (28).

In other words, Alger et al. teaches that the liquid coolant leaving the chamber (13) is fed directly to the reservoir (23) and that the liquid coolant **may** pass through the heat exchanger (28).

In contrast, independent claim 5 explicitly recites that pumping the liquid gallium, **serially**, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**

Thus, Alger et al., unequivocally, fails to disclose or suggest pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**, as set forth by independent claim 5.

In rebuttal to this position, the Examiner contends that Figure 1 of Alger et al. illustrates pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

As illustrated below, Figure 1 of Alger et al. illustrates pumping of the liquid gallium, serially, from the reservoir, through the nozzle, and from the neutron source assembly directly to the reservoir. Once in the reservoir, Alger et al. illustrates that the liquid gallium may travel directly back to the pump or the liquid gallium travel directly to a heat exchanger to remove heat from the liquid gallium. In this second scenario, the liquid gallium then travels from the heat exchanger to the reservoir.

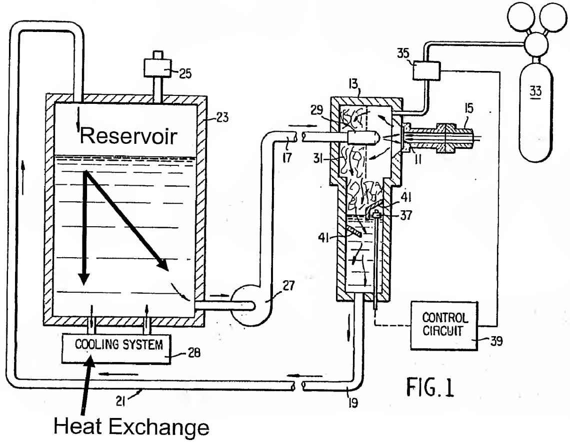

FIG.1

As noted above, independent claim 5 sets forth pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Thus, Alger et al., unequivocally, fails to disclose or suggest pumping the liquid gallium, **serially**, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Lastly, in addressing the Applicant's arguments, the Examiner dismisses the contention that the liquid gallium of Lidsky et al. is incompatible with the systems of Eggers and Pais et al. due to its corrosive nature and asserts that the Applicant has

admitted that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly.

Initially, the Examiner is respectfully requested to substantiate the validity of the Examiner's contention that the Applicant has admitted that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly.

The original specification does not discuss copper as being a material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly. Moreover, the Applicant has not expressly stated in any of the previous Response that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly. Therefore, the Examiner is respectfully requested to withdraw the unverifiable statement regarding Applicant's admissions concerning copper and further to refrain from making such unverifiable statements in future Office Actions.

The Examiner also asserts that Morel et al. (US Patent 6,258,620) discusses a liquid gallium container made of copper. It is respectfully noted that the Examiner has failed to formally include Morel et al. as a reference upon which the rejection under 35 U.S.C. §103 is based.

Although Morel et al. discloses, at column 5, lines 15-27, a shallow container made of copper for providing a liquid gallium sputtering source, Morel et al. fails to disclose liquid gallium can be utilized with a copper or aluminum based neutron source assembly as disclosed by Eggers.

It is respectfully submitted that shallow container made of copper for providing a liquid gallium sputtering source, as taught by Morel et al., is not subjected to the temperatures experienced within a neutron source assembly. As noted above, the inappropriateness of is temperature dependent. More specifically, the dissolution of the copper is temperature dependent.

Thus, since the temperatures within a neutron source assembly are very high, the use of liquid gallium as a coolant in a copper based neutron source assembly would be very problematic because the copper based neutron source assembly would begin to dissolve in the presence of the liquid gallium coolant.

Moreover, the Examiner has failed to demonstrate how Morel et al. teaches that copper is an adequate material for use with liquid gallium in an environment that is subjected to the temperatures realized within a neutron source assembly.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 5.

Accordingly, in view of all the reasons set forth above, the Honorable Board is respectfully requested to reconsider and overturn the present rejection under 35 U.S.C. §103.

C. Rejection of claim 8 under 35 U.S.C. §103

Claim 8 has been rejected under 35 U.S.C. §103 as being unpatentable over Eggers (US Patent 5,392,319) in view of Lidsky et al. (US Patent 5,784,423), Pias et al. (IEEE Article), and Alger et al. (US Patent 4,141,224). This rejection is respectfully traversed.

As submitted above, independent claim 8 sets forth a liquid cooling system for a neutron source assembly. The cooling system includes a reservoir of liquid gallium; a heat exchanger; a nozzle, the nozzle being submerged in liquid gallium, to provide a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of a low Z target material within the neutron source assembly; and means for serially circulating the liquid gallium from the reservoir through the nozzle to impinge upon the surface of the low Z target material within the neutron source assembly, from

the neutron source assembly directly to the heat exchanger, and from the heat exchanger to the reservoir.

Initially, as recognized by the Examiner, Eggers fails to disclose cooling a low Z target material of a neutron source assembly with liquid gallium. To meet this deficiency in Eggers, the Examiner assets that Eggers can be modified by the teachings of Lidsky et al. because the Examiner alleges that the teaching of Lidsky et al. with respect to cooling a low Z target material of a neutron source assembly with liquid gallium is an acceptable equivalent to cooling with water as taught by Eggers. The Examiner's motivation is incorrect.

More specifically, the liquid gallium of Lidsky et al. is incompatible with the system of Eggers because Eggers discloses a neutron source assembly constructed of aluminum. Liquid gallium dissolves aluminum or copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings of Eggers with the teaching of Lidsky et al. to realize a system to cool a low Z target material of a neutron source assembly with liquid gallium because the liquid gallium would dissolve the aluminum neutron source assembly of Eggers.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the aluminum neutron source assembly of Eggers, the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Eggers in that the system of Eggers would be rendered inoperable if liquid gallium were utilized as a coolant.

Moreover, as recognized by the Examiner, Eggers, and Lidsky et al., singly or in combination, fail to disclose a nozzle submerged in liquid gallium. To meet this deficiency in Eggers, and Lidsky et al., the Examiner assets that Eggers and Lidsky et al. can be modified by the teachings of Pais et al. because the Examiner alleges that the teaching of Pais et al. a nozzle submerged for cooling a low Z target material of a neutron source assembly. The Examiner's motivation is incorrect.

The liquid gallium of Lidsky et al. is incompatible with the system of Pais et al. because Pais et al. discloses passing the coolant over a block of copper. As noted above, liquid gallium dissolves copper in a matter of minutes or a few hours depending on temperature. Thus, one of ordinary skill in the art would not combine the teachings

of Lidsky et al. with the teaching of Pais et al. to realize a nozzle submerged for cooling a low Z target material of a neutron source assembly because the liquid gallium would dissolve the copper block of Pais et al.

Since Lidsky et al. discloses a coolant, liquid gallium, which would dissolve the copper block of Pais et al., the proposed combination of Eggers, Lidsky et al., and Pais et al. fails because the teachings of Lidsky et al. are antithetical to the teachings Pais et al. in that the system of Pais et al. would be rendered inoperable if liquid gallium were utilized as a coolant.

Furthermore, as recognized by the Examiner, Eggers, Lidsky et al., and Pais et al., singly or in combination, fail to disclose pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 1.

To meet this deficiency in the combined teachings of Eggers, Lidsky et al., and Pais et al., the Examiner proposes to modify the teachings with the teachings of Alger et al. The Examiner contends that Alger et al. teaches pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

Notwithstanding the Examiner's contentions, Alger et al. teaches pumping a liquid coolant, serially, from the reservoir (23), through the nozzle (29), such that the liquid coolant impinges upon a target material (11) in chamber (13) and cools the target material (11). Alger et al. further teaches that the liquid coolant exits the chamber (13) and flows directly back to the reservoir (23).

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In contrast, independent claim 8 explicitly recites that pumping the liquid gallium, **serially, from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

Thus, Alger et al., unequivocally, fails to disclose or suggest pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**, as set forth by independent claim 8.

In rebuttal to this position, the Examiner contends that Figure 1 of Alger et al. illustrates pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

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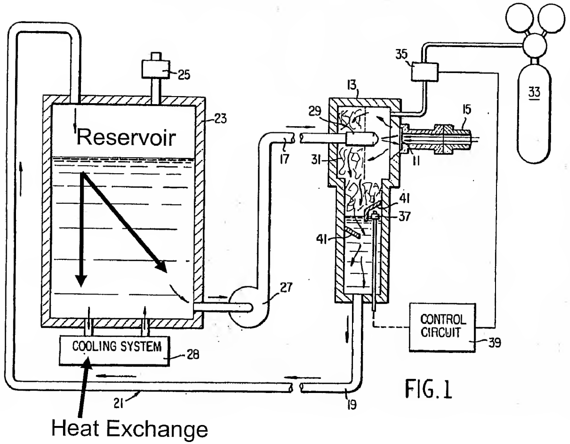

FIG.1

As noted above, independent claim 8 sets forth pumping the liquid gallium, **serially**, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, **from the neutron source assembly directly to a heat exchanger** to remove heat from the liquid gallium, and **from the heat exchanger to the reservoir**.

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Initially, the Examiner is respectfully requested to substantiate the validity of the Examiner's contention that the Applicant has admitted that copper is a proper material for constructing a container for a liquid gallium coolant used in conjunction with a neutron source assembly.

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Although Morel et al. discloses, at column 5, lines 15-27, a shallow container made of copper for providing a liquid gallium sputtering source, Morel et al. fails to disclose liquid gallium can be utilized with a copper or aluminum based neutron source assembly as disclosed by Eggers.

It is respectfully submitted that shallow container made of copper for providing a liquid gallium sputtering source, as taught by Morel et al., is not subjected to the temperatures experienced within a neutron source assembly. As noted above, the inappropriateness of is temperature dependent. More specifically, the dissolution of the copper is temperature dependent. Thus, since the temperatures within a neutron source assembly are very high, the use of liquid gallium as a coolant in a copper based neutron source assembly would be very problematic because the copper based neutron source assembly would begin to dissolve in the presence of the liquid gallium coolant.

Thus, the Examiner has failed to demonstrate how Morel et al. teaches that copper is an adequate material for use with liquid gallium in an environment that is subjected to the temperatures realized within a neutron source assembly.

In summary, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the teachings of Lidsky et al. would rendered the system of Eggers and the system of Pais et al., both, inoperable if liquid gallium were utilized as a coolant. Moreover, the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to render the presently claimed invention obvious to one of ordinary skill in the art because the proposed combination of Eggers, Lidsky et al., Pais et al., and Alger et al. fails to disclose or suggest pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir, as set forth by independent claim 8.

Accordingly, in view of all the reasons set forth above, the Honorable Board is respectfully requested to reconsider and overturn the present rejection under 35 U.S.C. §103.

Conclusion

Accordingly, for all the reasons set forth above, the Honorable Board is respectfully requested to reverse all the outstanding rejections. Also, an early indication of allowability is earnestly solicited.

Respectfully submitted,

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VIII. CLAIMS APPENDIX

1. (Appealed) A method of cooling a low Z target material of a neutron source assembly, comprising:

providing, by using a nozzle submerged in liquid gallium, a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the neutron source assembly to cool the low Z target material;

providing a reservoir of liquid gallium; and

pumping the liquid gallium, serially, from the reservoir, through the nozzle, such that the liquid gallium impinges upon the low Z target material in the neutron source assembly and cools the target material, from the neutron source assembly directly to a heat exchanger to remove heat from the liquid gallium, and from the heat exchanger to the reservoir.

4. (Appealed) The method of claim 1, wherein the target material comprises beryllium.

5. (Appealed) A neutron source assembly having a liquid cooled target, comprising:

an accelerator based neutron source including a low Z target material that is bombarded by accelerated particles to produce a neutron flux; and

a cooling system to circulate liquid gallium through said accelerator based neutron source to cool the low Z target material;

said cooling system including a nozzle, said nozzle being submerged in liquid gallium, providing a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of the low Z target material within the accelerator based neutron source;

said cooling system further including,

a reservoir of liquid gallium;

a heat exchanger, and

means for serially circulating said liquid gallium from said reservoir through said nozzle to impinge upon said surface of the low Z target material within said accelerator based neutron source, from said accelerator based neutron source directly to said heat exchanger, and from said heat exchanger to said reservoir.

7. (Appealed) The neutron source assembly of claim 5, wherein said means for circulating comprises a pump.

8. (Appealed) A liquid cooling system for a neutron source assembly, said cooling system comprising:

a reservoir of liquid gallium;

a heat exchanger;

a nozzle, said nozzle being submerged in liquid gallium, providing a submerged jet of concentrated liquid gallium in a direction normal to a non-bombarded surface of a low Z target material within the neutron source assembly; and

means for serially circulating said liquid gallium from said reservoir through said nozzle to impinge upon said surface of the low Z target material within the neutron source assembly, from the neutron source assembly directly to said heat exchanger, and from said heat exchanger to said reservoir.

IX. EVIDENCE APPENDIX

NONE

X. RELATED PROCEEDINGS APPENDIX

NONE